

City Planning Commission Communication

Department: Community Development Case #ZT-17-006 Applicant: Electric Guard Dog 550 Assembly Street, 5 th Floor Columbia, SC 29201	Ordinance No.	Planning Commission:
Subject/Title Request: Public hearing on the request of Electric Guard Dog, LLC to amend the text in Chapter 15.24.040(3)(e)(i) of the Municipal Code (Zoning Ordinance) to eliminate the required 300 foot separation distance between a 'fence, electrically charged security' and a residential district and/or legal nonconforming residential use (see Attachment A).		
Background On January 11, 2016, the Council Bluffs City Council passed and approved Ordinance No. 6255 which amended Chapter 15.03, <u>Definitions</u> by adding Section 15.03.271a ' fence, electrical security' and amended Chapter 15.24.040 <i>Supplemental Use and Site Development regulations</i> , Fence Regulations relative to adding 'fence, electrical security'. The amendment was drafted by a committee of City staff members and included input from the applicant. The purpose of this amendment was to legitimize an electrically charged security fence that was installed by the applicant around the Camping World's retail store site at 2802 South 21 st Street. The adopted amendment allowed property owners located in a C-2/Commercial District to install an electrically charged security fence to protect their capital investment from theft and vandalism. The amendment also included standards to insure that said fence did not put the general public at risk by a establishing a minimum separation distance, as stated in Section 15.24.0040(3)(e)(i) of the Council Bluffs Municipal Code (Zoning Ordinance): <i>(3) General Requirements for Residential and Commercial Districts</i> <i>(E) Fence, electrically charged security may be allowed in a C-2 District in accordance with Section 13.16.485, subject to the following conditions:</i> <i>(i) The site shall not be within 300 feet of a residential district, or legal non-conforming residential use.</i> The applicant has proposed to eliminate the required 300-foot separation distance between an electrically charged security fence and a residential zoning district in order to rectify an illegal fence they installed around the perimeter of Camping World's new vehicles sales lot. The fence was installed without a permit and is located 195 feet, as opposed to the required 300 feet, from a residential zoning district (see Attachment B). On August 15, 2017, the applicant appeared before the Council Bluffs Zoning Board of Adjustment and requested a variance to allow the fence to remain in its current location (Case #BA-17-003). The Board reviewed the request and then denied the variance on the basis that the property did not have an unnecessary hardship that prevented the applicant from installing the fence in accordance with City zoning standards. For reference purposes, the applicant provided safety studies for the electrically charged security fences (see Attachment C).		

This proposed text amendment will apply to all properties zoned C-2/Commercial District within the City. For reference purposes, the following images below show the electrically charged fenced installed by the applicant around the new Camping World vehicle sales lot:

Exhibit A: View of the electric security fence facing west

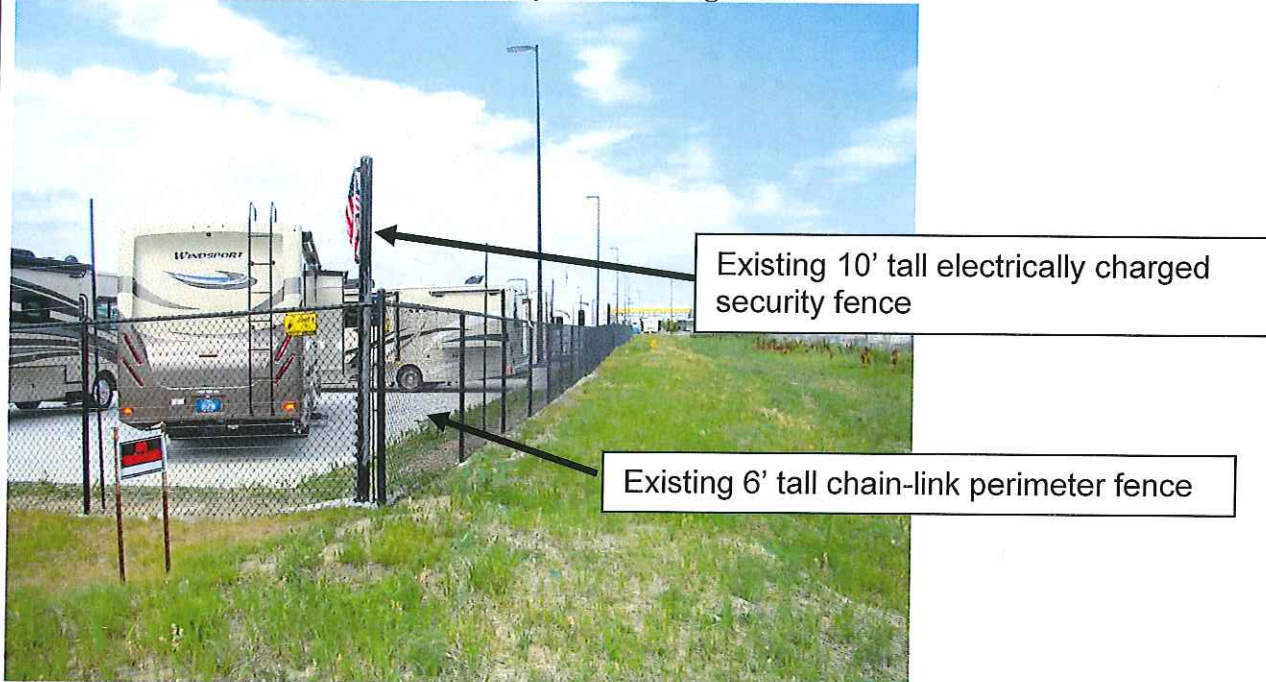


Exhibit B: View of the electric security fence that faces the residential area to the east



Exhibit C: View of residential dwellings to the east of the subject property.



All City departments and utility providers received a copy of the proposed text amendment. The following comments were received:

- Council Bluffs Fire Department stated the existing chain-link perimeter fence around the electrically charged security fence does not comply with the eight foot height requirement, as stated in Section 13.16.485(3), *Electric Code, Fence, electrically charged security*, of the Council Bluffs Municipal Code.
- Council Bluffs Building Division stated the electrically charged security fence was installed without a permit and does not comply with City standards. They are opposed to the text amendment request.
- The Community Development Department is opposed to the text amendment as the 300 foot separation requirements provides a reasonable balance between allowing commercial property owners to protect their capital investment with an electrically charged security fence while at the same time protecting the public from any risks associated with an electronically charged fence.

Recommendation

The Community Development Department recommends denial of the proposed text amendment based on reasons stated above.

Attachments

Attachment A: Proposed text amendment §15.24.040(3)(e)(i), *Fence regulations*, of the Supplemental Use and Site Development Regulations of the Municipal Code (Zoning Ordinance).

Attachment B: Location/zoning map showing the location of the illegal electrically charged security fence.

Attachment C: Safety studies for electrically charged fences

Prepared by: Christopher N. Gibbons, Planner

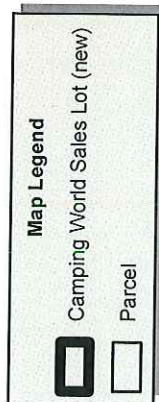
15.24.040 - Fence regulations

Fences, including masonry walls, vegetation, ornamental iron, chain link, open wood, solid wood or metal, forming a physical barrier, placed on private property, used for any purpose shall conform to the following requirements:

(3) General Requirements for Residential and Commercial Districts.

- (A) In a front yard or a street side yard, the height of a fence shall not exceed four feet, unless its placement meets the setback requirements for principal and accessory structures. Exception: ornamental iron fences located in front or street side yards may exceed four feet in height, but are limited to six feet in overall height.
- (B) No solid fence shall be placed within a front yard or street side yard which creates a safety hazard by obstructing the clear view of pedestrians or vehicles.
- (C) In an interior side yard or rear yard, the height of a fence, excepting vegetation fences, shall not exceed six feet. Fences in residential areas proposed to exceed six feet in height shall be reviewed on a case-by-case basis by the mayor or designee.
- (D) Security fences with sharp or pointed projections or containing barbed wire strands may be permitted in a C-2 district when placed on top of an otherwise conforming fence, if the following conditions are met:
 - (i) The site shall not abut any residential district; and
 - (ii) The use shall comply with all requirements for conforming uses and the site development regulations in a C-2 district.
- (E) Fence, electrically charged security may be allowed in C-2 District in accordance with [Section 13.16.485](#), subject to the following conditions:
 - ~~(i) The site shall not be within 300 feet of a residential district, or a legal non-conforming residential use;~~
 - (ii) The use shall comply with all requirements for conforming use and site development regulations in a C-2 District;
 - (iii) Shall not be located within the area defined as the front yard setback, street side yard setback, or the area between a structure and the front property line or street side property line, if greater than the minimum required setback; and
 - (iv) Shall not be located within the corridor design overlay district (CDO).

CITY OF COUNCIL BLUFFS - CITY PLANNING COMMISSION LOCATION/ZONING MAP - CASE #ZT-17-006



0 100 200
1 Inch = 200 Feet

2016 Aerial Photograph



Note: Subject property highlighted in red.



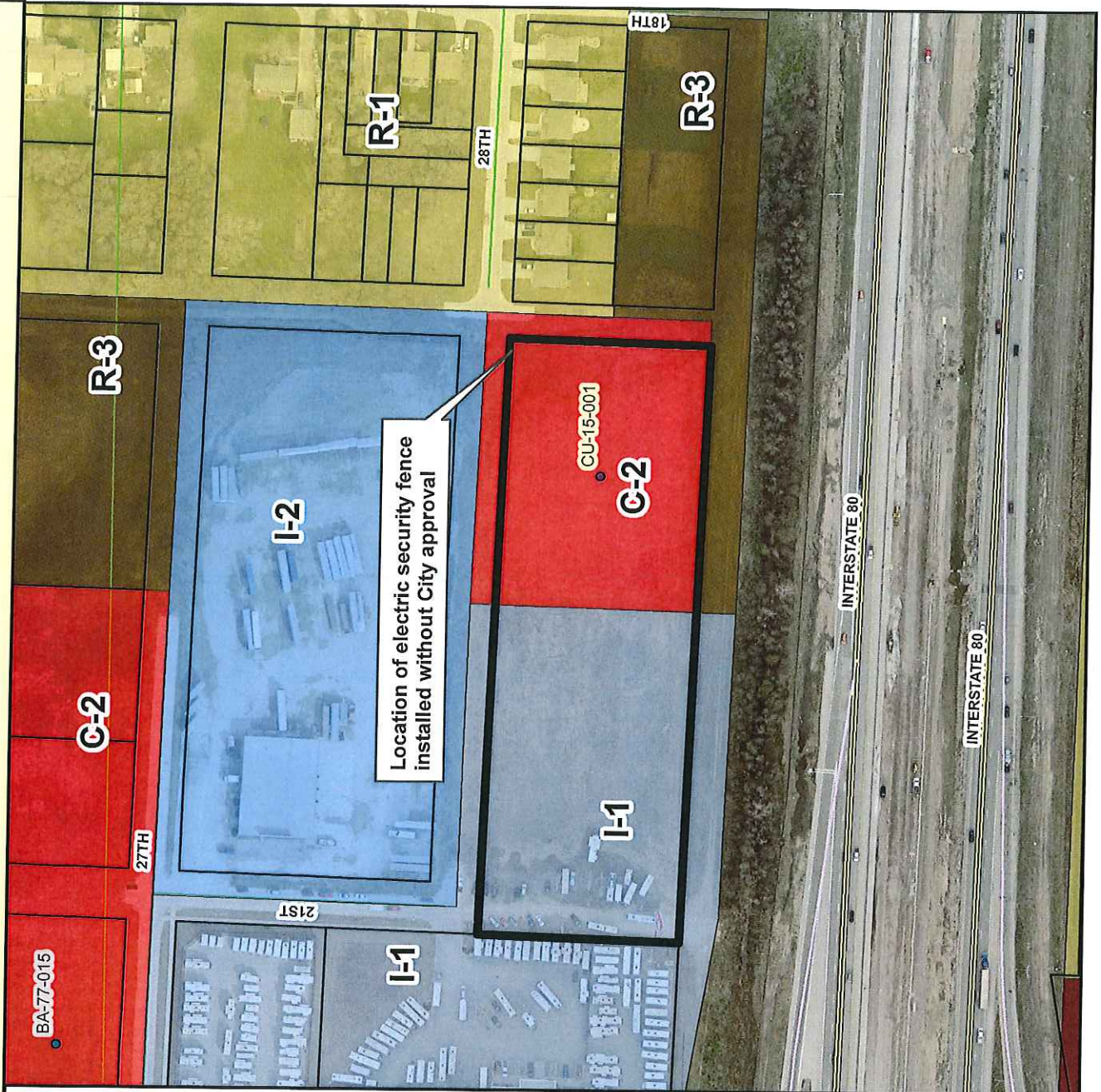
Last Amended: 9/13/17



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DISCLAIMER

This map is prepared and compiled from various sources and is not a legal document. It is for informational purposes only. The City of Council Bluffs does not warrant the accuracy or completeness of the information contained on this map. The user assumes all responsibility for the information contained on this map.





Safety of electric security fences

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Electric current shocks us, not voltage

Most of us can remember receiving an electric shock; it can happen during a regular day. How can that happen and when? Walking across a carpet during dry weather, then touching a doorknob and feeling a spark that jumps to the doorknob is a very common way. Placing a finger inside of a lamp socket that inadvertently was turned on is yet another. Touching the spark plug in a car or lawn mower has happened to many people as well. But why are we all still alive after receiving these electric shocks during a regular day? *We are still alive because even though the voltage is high, not enough electric current flowed through our heart.*

Even when the voltage is high, when the current flows for only a very short duration we can not be electrocuted. Furthermore, it is even hard to get electrocuted in the home because the power line voltage of 120 volts can't drive enough continuous current through the high resistance of our dry skin. Kitchens and bathrooms fall in a different category; they are dangerous places because our skin may be wet. When our skin is wet, our skin resistance is low and permits a large electric current to flow through the body as shown in Figure 1. A large enough current can cause ventricular fibrillation. During ventricular fibrillation the pumping action of the heart ceases and death occurs within minutes unless treated. In the United States, approximately 1000 deaths per year occur in accidents that involve cord-connected appliances in kitchens, bathrooms, and other wet locations.

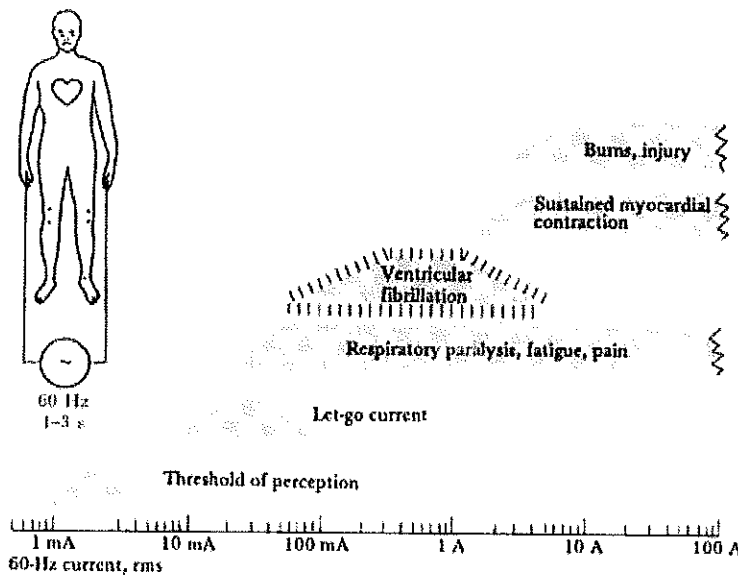


Figure 1 Physiological effects of electricity. Threshold or estimated mean values are given for each effect in a 70 kg human for a 1- to 3 s exposure to 60 Hz current applied via copper wires grasped by the hands. From W. A. Olson, Electrical Safety, in J. G. Webster (ed.), *Medical Instrumentation Application and Design*, 3rd ed., New York: John Wiley & Sons, 1998.

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ATTACHMENT C

Short duration pulses are safer than continuous electric current

Figure 2 shows that shock durations longer than 1 second are the most dangerous. Note that as the shock duration is shortened to 0.2 seconds, it requires much more electric current to cause ventricular fibrillation. Electric security fences have taken advantage of this fact by shortening their shock duration to an even shorter duration of about 0.0003 seconds. Therefore, electric security fences are safe and do not lead to ventricular fibrillation due to the short 0.0003 second shock duration. .

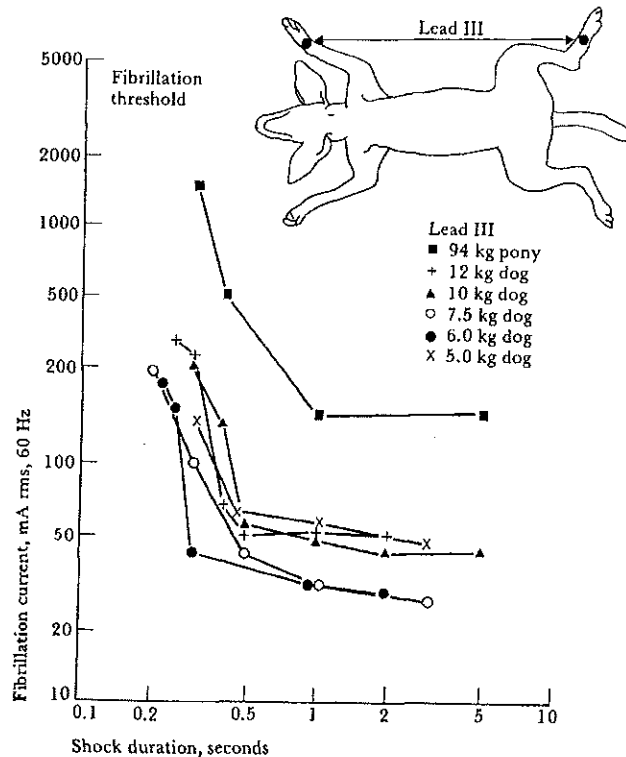


Figure 2 Thresholds for ventricular fibrillation in animals for 60-Hz ac current. Duration of current (0.2 to 5 s) and weight of animal body were varied. Fibrillation current versus shock duration for a 70 kg human is about 100 milliamperes for 5 second shock duration. It increases to about 800 milliamperes for 0.3 second shock duration. From L. A. Geddes, *IEEE Trans. Biomed. Eng.*, 1973, 20, 465-468.

Electricity near the heart is most dangerous

There are four situations where electricity may be applied close to the heart. (1) Figure 3(b) shows when a catheter tube is threaded through a vein into the heart, any accidental current is focused within the heart and a small current can cause ventricular fibrillation. (2) Cardiac pacemakers also pass electric current inside the heart, but the current is kept so small that ventricular fibrillation does not occur. (3) A Taser weapon may rarely shoot a dart between the ribs very close to the heart and apply a 0.0001 second pulse, but this has not been shown to cause ventricular fibrillation. Typically when a person takes an overdose of drugs, he creates a disturbance, police are called, the person refuses to obey, the police Taser him, afterwards he dies of a drug overdose, and the newspapers report, "Man dies after Taser shot." (4) A defibrillator applies a 0.005 second, 40 ampere electric current. This causes massive heart contraction that can change ventricular fibrillation to normal rhythm and save a life.

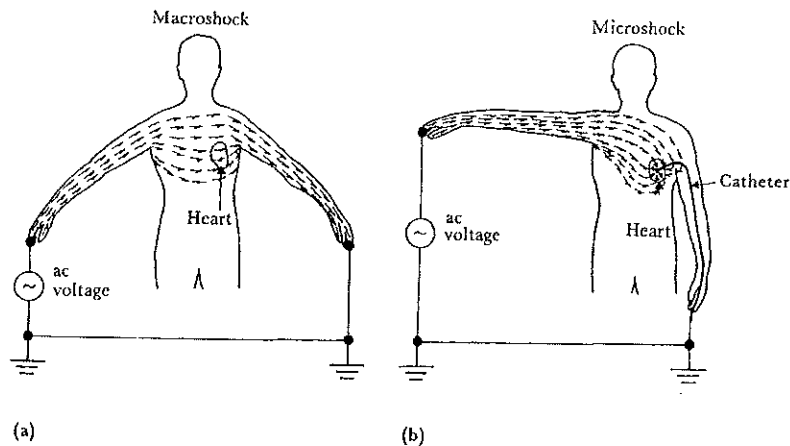


Figure 3 Effect of entry points on current distribution. (a) *Macroshock*, externally applied current spreads throughout the body, (b) *Microshock*, all the current applied through an intracardiac catheter flows through the heart. From F. J. Weibell, "Electrical Safety in the Hospital," *Annals of Biomedical Engineering*, 1974, 2, 126-148.

When comparing an electric security fence to the above examples, we know that an electric security fence is similar to Figure 3(a). Why do we know that? If a person contacts an electric fence, electric current is concentrated in the limbs and causes a deterrent shock; when it continues to pass through the torso, it spreads out and becomes more diffuse. Therefore as shown in Figure 3(a) and in Figure 2 electric security fences are safe because the deterrent shock spreads out and becomes more diffuse and is of a very short duration.

Only power lines cause ventricular fibrillation

Table 1 shows that short duration electric pulses, even though applied near the heart do not cause ventricular fibrillation. In contrast, the continuous current from power lines kills 1000 persons per year.

Table 1 Only power lines cause ventricular fibrillation

	Duration of pulse in seconds	Current in amperes	Likely to be applied near heart?	Caused ventricular fibrillation?
Power lines	Continuous	0.1	No	1000 per year
Electric security fence	0.0003 0.8 times/sec	10	No	No
Taser	0.0001 19 times/sec	2	May be	No
Cardiac pacemaker	0.001 1 time/sec	0.005	Yes	No
Defibrillator	0.005 1 time	40	Yes	Cures ventricular fibrillation
Spark plug	0.00002 1 time	0.2	No	No
Doorknob	0.00002 1 time	0.2	No	No

**Sentry Security Systems, LLC position on the relationship of security fences
to codes and standards**

Electric fencing is used safely throughout the world, with applications for both animal control and commercial security. In a commercial security setting, security fences deter crime and help apprehend criminals. The mere presence of a security fence discourages unlawful entry, theft and the destruction of property. Additionally, it is easier to apprehend the determined criminal because the owner and police are notified instantaneously when the criminal distorts or breaks the fence. Security fences also protect the people who work at a site, providing business owners and employees significant peace of mind.

The security fence sold by Sentry Security Systems is powered by a 12 volt DC marine (or similar) battery. The National Electric Code does not cover battery powered products such as smoke alarms. Therefore, the security fence sold by Sentry Security Systems is not covered by the NEC.

There is in fact no US standard that addresses security fences whether main or battery powered. UL 69 addresses animal control fences but not security fences. There is, however, a good international standard - IEC 60335-2-76 - that addresses security fences. This standard is attached for your information.

We respectfully request that you determine that, as a battery powered device, security fences do not fall under the National Electric Code.

Safety of electric fence energizers

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Abstract

The strength-duration curve for tissue excitation can be modeled by a parallel resistor-capacitor circuit that has a time constant. We tested five electric fence energizers to determine their current-versus-time waveforms. We estimated their safety characteristics using the existing IEC standard and propose a new standard. The investigator would discharge the device into a passive resistor-capacitor circuit and measure the resulting maximum voltage. If the maximum voltage does not exceed a limit, the device passes the test.

Key words: strength-duration curve, cardiac stimulation, ventricular fibrillation, electric safety, electric fence energizers, standards.

1. Introduction

The vast majority of work on electric safety has been done using power line frequencies such as 60 Hz. Thus most standards for electric safety apply to continuous 60 Hz current applied hand to hand. A separate class of electric devices applies electric current as single or a train of short pulses, such as are found in electric fence energizers (EFEs). A standard that specifically applies to EFEs is IEC (2006). To estimate the ventricular fibrillation (VF) risk of EFEs, we use the excitation behavior of excitable cells. Geddes and Baker (1989) presented the cell membrane excitation model (Analytical Strength-Duration Curve model) by a lumped parallel resistance-capacitance (RC) circuit. This model determines the cell excitation thresholds for varying rectangular pulse durations by assigning the strength-duration rheobase currents, chronaxie, and time constants (Geddes and Baker, 1989). Though this model was originally developed based on the experimental results of rectangular pulses, the effectiveness of applying this model for other waveforms has been discussed (IEC 1987, Jones and Geddes 1977). The charge-duration curve, derived from the strength-duration curve, has been shown in sound agreement with various experimental results for irregular waveforms. This permits calculating the VF excitation threshold of EFEs with various nonrectangular waveforms. We present measurements on electric fence energizers and discuss their possibility of inducing VF.

2. Mathematical background and calculation procedures

Based on the cell membrane excitation model (Weiss-Lapique model), Geddes and Baker (1989) developed a lumped RC model (analytical strength-duration curve) to describe the membrane excitation behavior. This model has been widely used in various fields in electrophysiology to calculate the excitation threshold. Figure 1 shows the normalized strength-duration curve for current (I), charge (Q) and energy (U). The expression of charge is also known as the charge-duration curve which is important for short duration stimulations.

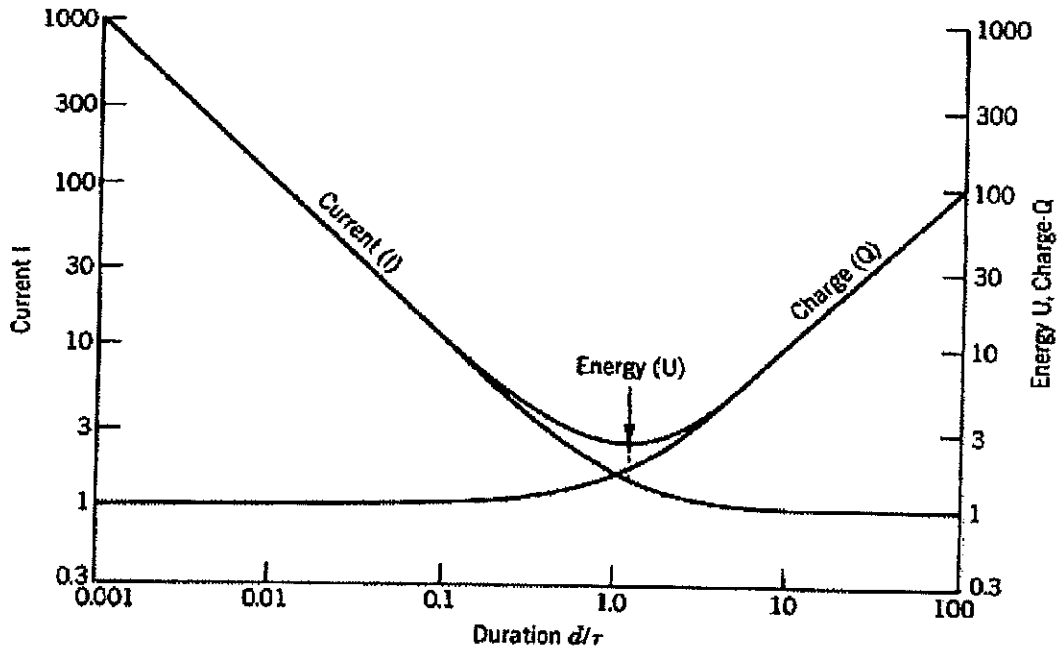


Figure 1. Normalized analytical strength-duration curve for current I , charge Q , and energy U . The x axis shows the normalized duration of d/τ . Note that for $d \ll \tau$, Q is constant and the most appropriate variable for estimating cell excitation. (from Geddes and Baker, 1989).

The equation for the strength-duration curve is (Geddes and Baker, 1989),

$$\Delta v = IR(1 - e^{-\frac{t}{\tau}}), \quad (1)$$

where I is a step current intensity, R is the shunt resistance, Δv is the depolarization potential threshold which is about 20 mV for myocardial cells, τ is the RC time constant, and t is the time I is applied.

If we let the stimulation duration go to infinity, the threshold current is defined as the rheobase current ($I = b$). If we substitute I in equation (1) by b and define the threshold current $I_d = \Delta v/R$ for the stimulation with duration d . Equation (1) becomes,

$$I_d = \frac{b}{1 - e^{-\frac{d}{\tau}}}. \quad (2)$$

We can calculate the threshold charge (Q_d) by integrating equation (2) and it becomes,

$$Q_d = I_d d = \frac{bd}{1 - e^{-\frac{d}{\tau}}}, \quad (3)$$

For short duration stimulation ($d \ll \tau$) with duration shorter than 0.1 times the RC time constant, equation (3) can be approximated by equation (4) and it yields equation (5),

$$1 - e^{-\frac{d}{\tau}} \approx \frac{d}{\tau}, \quad (4)$$

$$Q_d = b\tau \quad (5)$$

Equation (5) suggests that the charge excitation threshold for short duration stimulation is constant and equals the product of the RC time constant τ and the rheobase b . Geddes and Bourland (1985) showed that the charge-duration curve for single rectangular, trapezoidal, half sinusoid and critically damped waveforms had a good agreement for short duration stimulations. Therefore we used the same model to estimate thresholds for stimulation sources where I was not constant, under the same stimulation setting.

Cardiac cell excitation has been intensively studied at the 60 Hz power line frequency because most accidental electrocutions occur with 60 Hz current, which has a longer duration relative to the cardiac cell time constant of about 2 ms. However, EFEs operate with pulse durations much shorter than the time constant.

3. Methods

Figure 2 shows our experimental test set-up. The EFEs under test consist of Gallagher Group Ltd PowerPlus B600 (EFE1), Gallagher Group Ltd PowerPlus B280 (EFE2), Speedrite HPB (EFE3), Intellishock 20B (EFE4) and Blitzter 8902 (EFE5) EFEs. The short duration electrical pulses from these EFEs are passed through a series of eleven 47 Ω (ARCOL D4.29, HS50 47 R F) resistors which measure 518 Ω , which represents approximately the internal resistance of the human body. It is further connected to two 18 Ω (RH 10 207 DALE 10 W 3%) resistors connected in parallel which measure 9.08 Ω . This is used as the sensing resistor across which the oscilloscope measures the output voltage. For these very short pulses it is important to use noninductive resistors because the same current flowing through a resistor that has substantial inductance will measure a larger current than a resistor that is noninductive. To reduce electromagnetic interference, a faraday cage, covered with aluminum foil, was connected to ground. This diverted the electromagnetic interference to ground. The data were collected in EXCEL format from a disk in the Agilent 54621 oscilloscope. The calculations for different parameters presented in Table 1 and the Figures 3–5 were plotted using MATLAB.

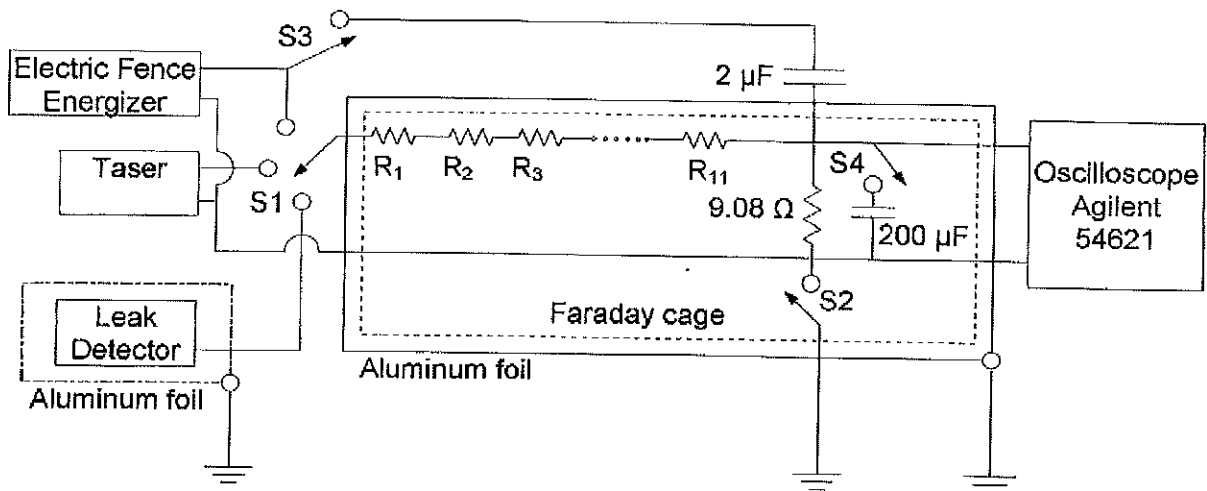


Figure 2. The EFE is selected by S1. The current flows through a string of 47 Ω resistors R_1 – R_{11} (total 518 Ω) which approximates the internal body resistance of 500 Ω . The 9.08 Ω yields a low voltage that is measured by the oscilloscope.

3.1. Determination of current

EFEs are used in conjunction with fences wires to form animal control fences and security fences. We tested five EFEs (EFE1–EFE5) using the experimental set-up in Figure 2 and obtained the output currents shown in Figure 3.

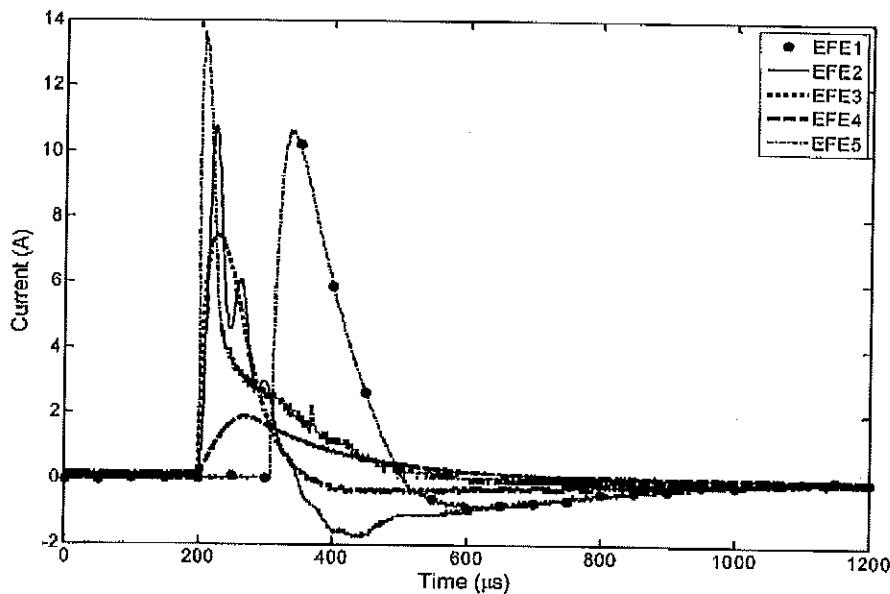


Figure 3. The output current waveform for five EFEs. EFE1 yields about 7.75 A for 151 μs = 1170 μC , EFE2 yields about 3.34 A for 345 μs = 1150 μC , EFE3 yields about 5.69 A for 91 μs =

518 μC , EFE4 yields about 1.25 A for 252 μs = 315 μC and EFE5 yields about 5.7 A for 137 μs = 781 μC .

4. Results

Table 1 shows the approximate results for the rms current, power, duration and charge for all the EFEs.

Table 1 Approximate results for all EFEs.

EFEs		EFE1	EFE2	EFE3	EFE4	ECF5
Parameters	Units					
A. (IEC)						
Total Energy	A^2ms	7.94	4.04	3.10	0.42	4.69
95% Energy Duration	μs	129	346	91	253	138
I_{rms}	A	7.65	3.33	5.69	1.25	5.69
IEC Standard I_{rms}	A	13.0	6.21	16.8	7.85	7.37
Pass IEC Standard	Yes/No	Yes	Yes	Yes	Yes	Yes
B. Proposed standard						
Voltage	V	3.88	2.91	NAv	NAv	NAv
Duration	μs	233	132			
Current	A	3.33	4.41			
Charge	μC	776	582			

NA- not applicable, NAv- not available

IEC (2006) defines in 3.116 “impulse duration: duration of that part of the impulse that contains 95% of the overall energy and is the shortest interval of integration of $P(t)$ that gives 95% of the integration of $P(t)$ over the total impulse. $I(t)$ is the impulse current as a function of time.” In 3.117 it defines “output current: r.m.s. value of the output current per impulse calculated over the impulse duration.” In 3.118 it defines “standard load: load consisting of a non-inductive resistor of $500 \Omega \pm 2.5 \Omega$ and a variable resistor that is adjusted so as to maximize the energy per impulse or output current in the 500Ω resistor, as applicable.” In 22.108, “Energizer output characteristics shall be such that – the impulse repetition rate shall not exceed 1 Hz; – the impulse duration of the impulse in the 500Ω component of the standard load shall not exceed 10 ms; – for energy limited energizers the energy/impulse in the 500Ω component of the standard load shall not exceed 5 J; The energy/impulse is the energy measured in the impulse over the impulse duration. – for current limited energizers the output current in the 500Ω component of the standard load shall not exceed for an impulse duration of greater than 0.1 ms, the value specified by the characteristic limit line detailed in Figure 102; an impulse duration of not greater than 0.1 ms, 15 700 mA. The equation of the line relating impulse duration (ms) to output current (mA) for $1\,000 \text{ mA} < \text{output current} < 15\,700 \text{ mA}$, is given by impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$.” We used these definitions and calculated the total energy, the shortest duration where 95% of the total energy occurs, the rms current for that duration from Figure 3 for the EFEs (EFE1–EFE5). Similarly we calculated the output current using the relationship impulse duration = $41.885 \times 10^3 \times (\text{output current})^{-1.34}$, provided by the IEC for all the EFEs (EFE1–EFE5). Table 1 lists these under the heading “A. (IEC)”. Table 1 shows that all the EFEs pass the IEC standard.

5. Proposed new standard

IEC (2006) uses the rms current for the shortest duration where 95% of the total energy occurs as the standard to determine if the EFE is safe for use. Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites the cells. We propose a simple experimental set-up shown in Figure 2 to determine the maximum amount of charge that would flow from the EFEs and cause cardiac cell excitation. The cardiac cell is modeled as an RC circuit in Fig. 2 with $R = 9.08 \Omega$ and $C = 200 \mu\text{F}$ (GECONOL 9757511FC $200 \mu\text{F} \pm 10\%$ 250 VPK) with the RC time constant of 1.82 ms. For the EFEs (EFE1 and EFE2) the switches S1 and S4 are closed. This allows the $200 \mu\text{F}$ capacitor to charge rapidly (about $100 \mu\text{s}$) and discharge fairly slowly ($\tau = RC = 1.82 \text{ ms}$). Figures 4 and 5 show the voltage vs time waveforms for the different EFEs. The test was not performed for electric fence energizers EFE3–EFE5.

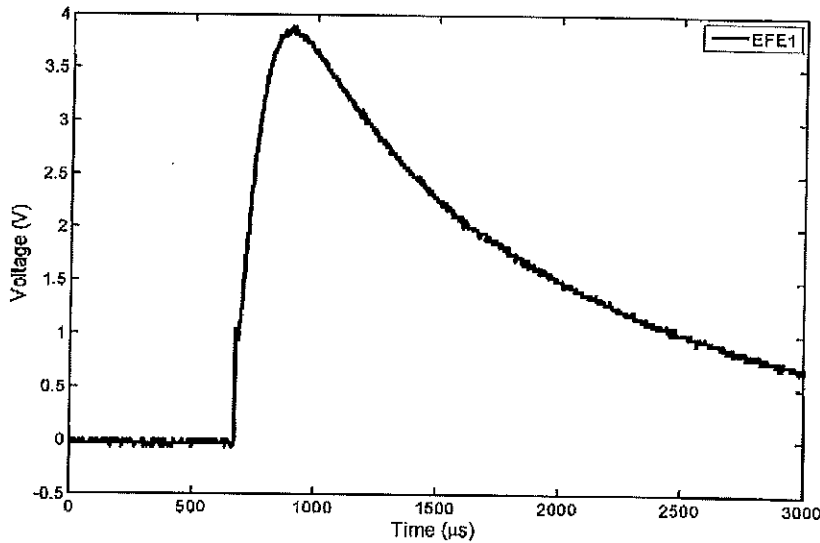


Figure 4. Output voltage waveform for EFE1. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200 \mu\text{F} \times 3.88 \text{ V} = 775 \mu\text{C}$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200 \mu\text{F} \times 3.88 \text{ V})/233 \mu\text{s} = 3.33 \text{ A}$.

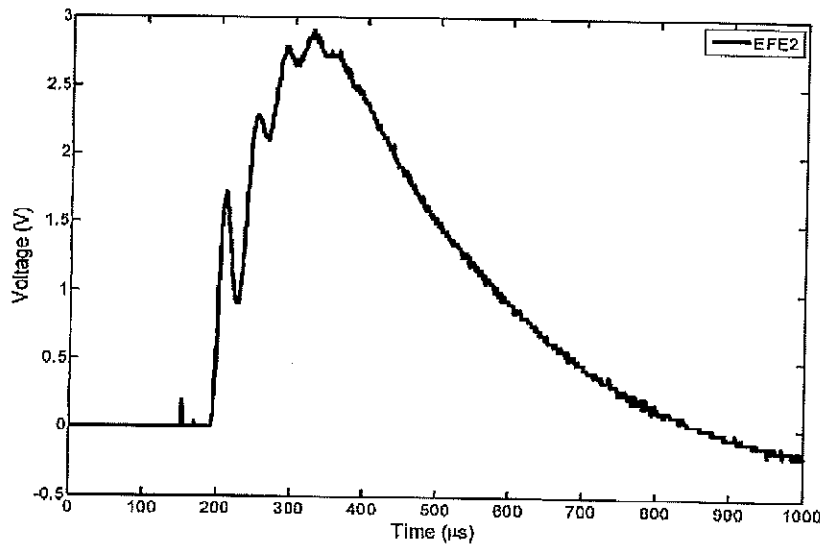


Figure 5. Output voltage waveform for the electric fence energizers EFE2. The maximal charge that flows through the cardiac cell model is given by $Q = CV = 200 \mu\text{F} \times 2.91 \text{ V} = 582 \mu\text{C}$, the current during which the capacitor charges to maximal value is given by $I = CV/T = (200 \mu\text{F} \times 2.91 \text{ V})/132 \mu\text{s} = 4.41 \text{ A}$.

6. Discussion

Geddes and Baker (1989) have shown that for pulses shorter than the cardiac cell time constant of 2 ms, the electric charge is the quantity that excites cardiac cells. Because the first half wave is the largest, the charge integrated in the first half wave determines cardiac cell excitation. The next half wave discharges the cardiac cell capacitance and does not contribute to cardiac cell excitation. Thus we list integral $I(t) = \text{charge } Q$ in Table 1.

IEC (2006) integrates $P(t)$, which is roughly equal to $I(t)$. Their Figure 102 roughly follows charge.

We propose revising EFE standards for measuring current to determine a safety standard to prevent VF. The new standard would measure cardiac cell excitation. It would not require the complex calculations required to determine “The current which flows during the time period in which 95 percent of the output energy (is delivered).” It would use a simple circuit similar to that in Figure 2 composed of resistors and a capacitor. The investigator would discharge the device into the circuit and measure the maximum voltage. If the maximum voltage does not exceed 5 V (as a conservative estimate), the EFE passes the test. The 500Ω resistor closely approximates the resistance of the body and determines the current that flows through the body.

Acknowledgements

We thank L. Burke O’Neal and Silas Bernardoni for their help and suggestions.

References

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- Jones M and Geddes L A 1977 Strength duration curves for cardiac pacemaking and ventricular fibrillation *Cardiovasc. Res. Center Bull.* **15** 101–12